THE WESTERN GAS CONSTRUCTION CO.

GAS ENGINEERS AND BUILDERS

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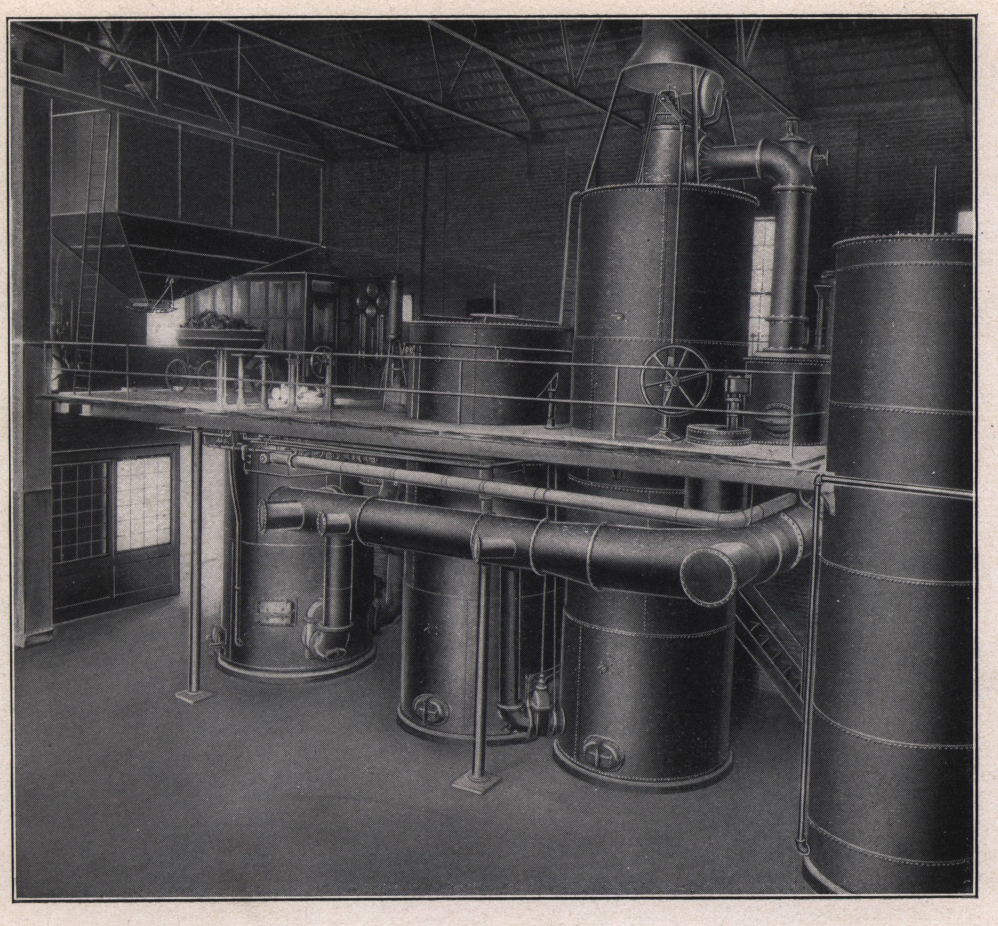
WATER GAS APPARATUS



"THE WESTERN" TYPE.

"Points" in Water Gas Principles

AS APPLIED TO

"The Western" Water Gas Machines.

The paramount aim of every gas manager is to furnish to his customers a stable product of very best quality at the least cost of production From the manufacturing standpoint the aim must be to operate the plant in such manner that best results as to efficiency and capacity are obtained at all times.

In considering the manufacture of carburetted water gas, the efficiency and capacity of the apparatus are almost entirely governed by the *conditions* existing in the generator, carburetter and superheater, where the gas is made, enriched and fixed. And, for the successful accomplishment of the aim, the problem therefore narrows to the maintenance of the most favorable operating conditions and to the complete control of same at all times.

In the determination of these proper conditions, a subject of a dual nature presents itself; namely, the manufacture of the blue water gas, and the subsequent enrichment of same. And for a stable product, the problem is, first, to settle upon the conditions for obtaining best quality and quantity of blue gas in the generator with least expenditure for fuel and care of fuel bed; second and equally important—the problem concerns itself with the means of obtaining best oil results.

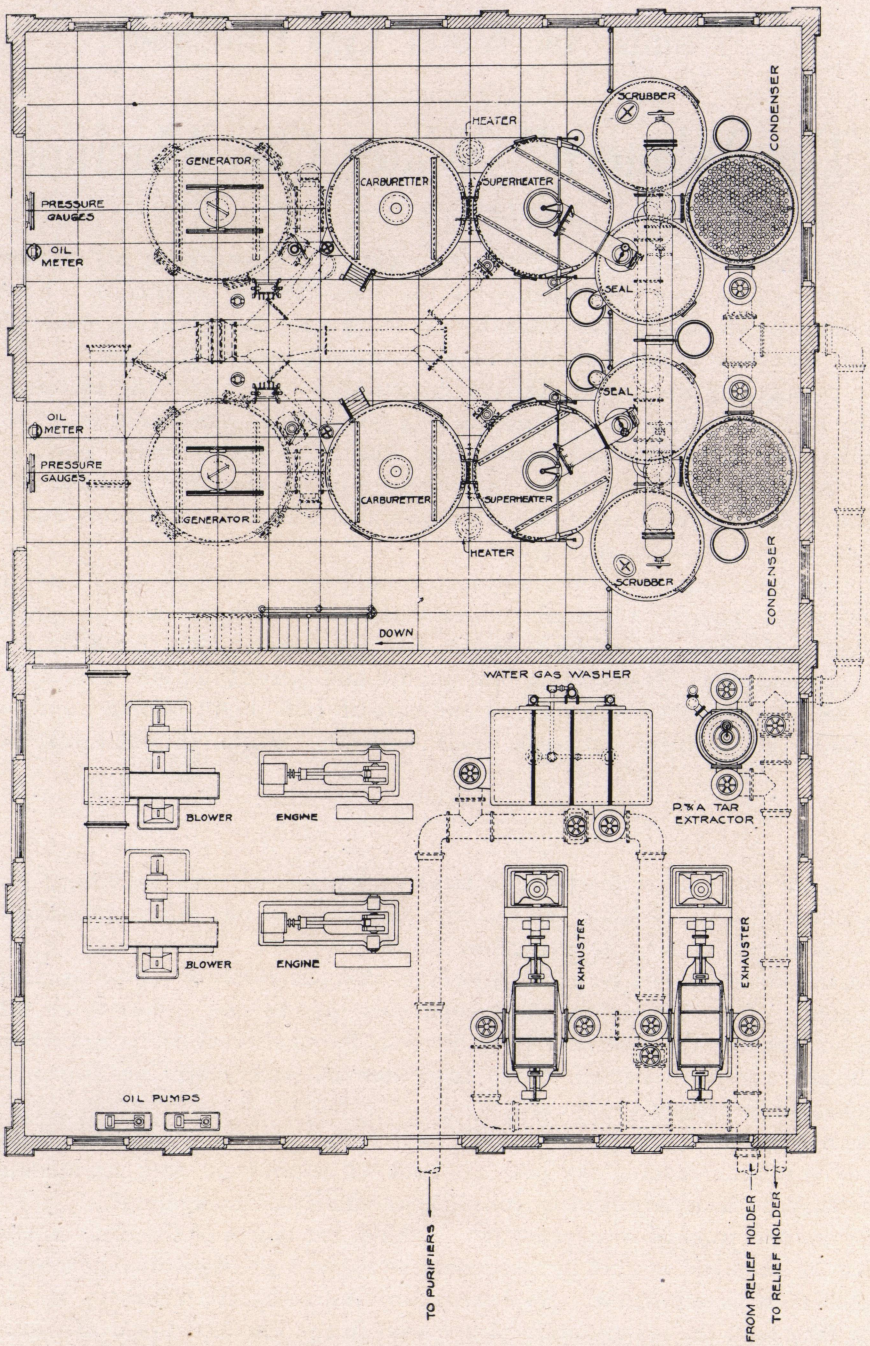
It is our purpose in this Bulletin to call attention to what is taking place in the machine during the blow and the run, and to point out what conditions must exist in different parts for securing best results.

At the outset it is to be noted, however, that the methods of attainment and maintenance of the proper operating conditions may be very different for different machines, because the kind of fuel to be used, the quality of oil to be carburetted, and the size and construction of the machines all have direct bearing upon the conditions to be sought.

The Blow.

As above stated, the purpose of the following notes is to point out the conditions to be sought, leaving the best methods of attainment and maintenance, as is necessary, to be determined by direct observation and experiment.

In the operation of any water gas machine, the object of the blast is primarily to raise the deep bed of fuel in the generator to the highest practicable temperature in the shortest time possible. As a secondary and necessary object to be attained during the blow, the recuperation of the heat in the checker brick of carburetter and superheater is to be brought about by leading the heated gaseous products from the generator through these two following chambers.



PLAN OF 2-11'0" EXTENDED CARBURETTER SUPERHEATER MACHINES, SHOWING ALSO THE ARRANGEMENT OF APPARATUS IN BLOWER ROOM.

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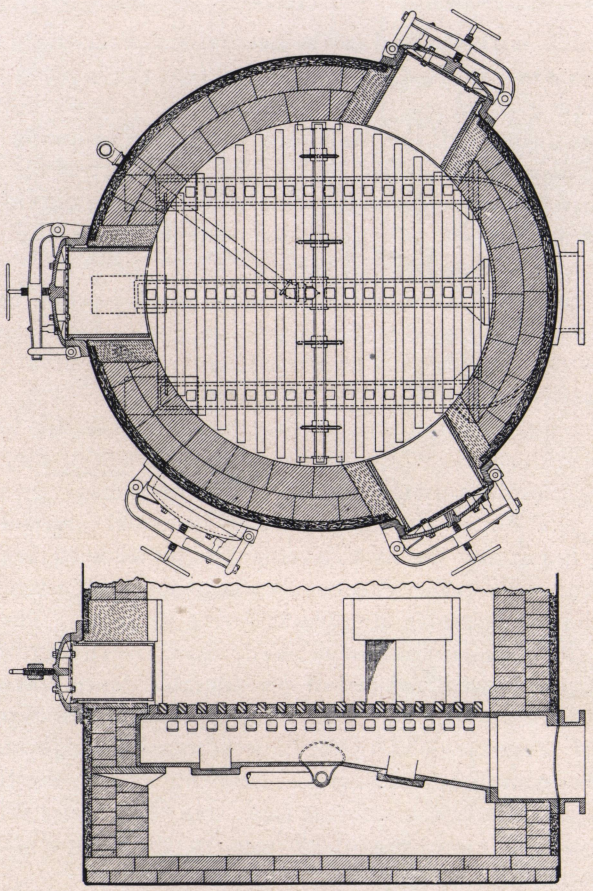
The blow begins with the fuel in the generator at a relatively low temperature, which temperature rises gradually from the moment the blast is turned on. As a consequence of this gradual rise of temperature, it follows that the relative proportion of the constituents of the blast products are continually changing; a gas richest in combustible being formed during the latter part of the blow. The reason for this is the more extensive decomposition of the carbon dioxide (CO_2) formed in the lower parts of the bed, to carbon monoxide (CO) in the upper layers, by contact with the highly incandescent carbon.

Now since carbon burned to the dioxide liberates more than three times as much heat as when it is burned to the monoxide, it is clear that the less carbon monoxide formed the more heat is developed, and by this more complete combustion, a quicker heating of the fuel bed is accomplished.

If there is a high percentage of carbon monoxide in the blast products, this leads to losses of either fuel or oil, or both. Because *unless* the gas is burned in the checker brick chambers by the admission of a secondary air supply, there is a waste of combustible out of the stack, which in usual practice is far too great; again, *if* the gas is burned, the heat developed together with the sensible heat of the gaseous products raises the checker brick to too high a temperature with the resultant formation of excessive lampblack during the run. Therefore the object must be to keep the blast products *lean*; and, since the energy of a gas formed by passing air through a heated fuel bed of considerable depth varies inversely with the power of the blast and directly with the temperature and depth of fuel bed, the correct method of procedure during the blow is to utilize high blast pressures, thus burning the fuel as completely as possible. By this means, the fuel bed is brought to its proper temperature in the shortest time, and the greater sensible heat of the blast products plays a more important role in the recuperation of the heats in checker brick than can be accomplished with slower blast.

Another point to be observed in connection with the blow is the maintenance of an entirely uniform and uniformly heated fuel bed. This can only be provided by supplying the air for a blast at uniform pressure to all parts of the grate Unless this obtains, there is an uneven fire as the inevitable result, and the accompanying evils of "blow holes" and "steam spots" are points only too well known. With an uneven fire, the air for the blast finds its way through the hottest parts of the fuel bed, and the steam shunts through the cooler parts during the run, which results in inability to control the conditions which must exist in the generator. And this very lack of control in turn renders impossible the fine adjustment in the admixture of the oil vapors which is essential in best and most economical operation.



DIVIDED BLAST GRATE, SHOWING ALSO STEAM DISTRIBUTORS.

Summary

To summarize on the conditions to be sought during the blow for best results as to efficiency and capacity of the machine, it is essential:

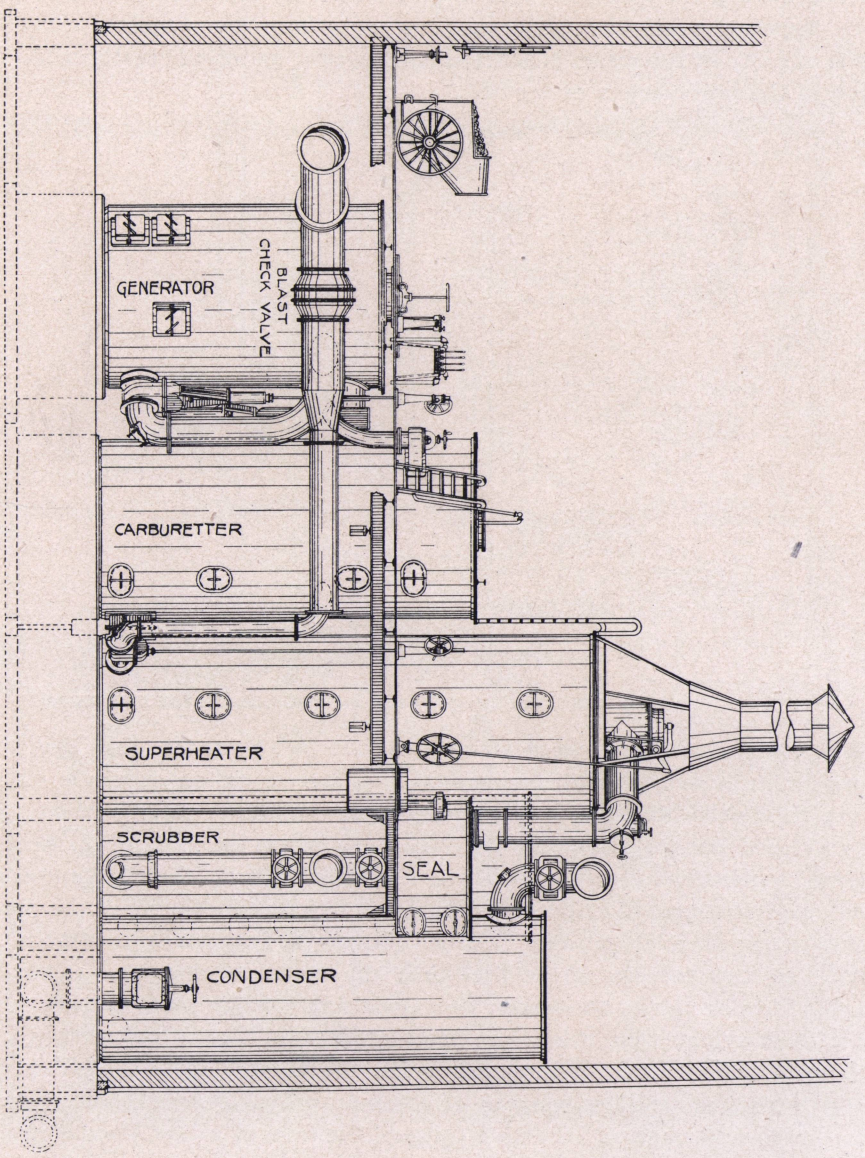
First. To burn the fuel in the generator as completely as possible. The fuel bed is thus brought to heat in the quickest time and the checker bricks are not overheated.

Second, To provide for an even, hot fire over the entire grate by distributing the air for blast equally to all parts of the fire. In this connection also, it is to be noted, that the fuel bed should always be the deepest possible, by keeping the generator filled well up to the gas offtake. This point provides for minimum undecomposed steam in the blue gas, which is the condition for least waste in steam consumption.

The Run

Having the machine properly heated, the conditions next to be considered are those necessary for best quality and quantity of blue gas. The blast has provided a highly incandescent fuel bed, which is ready for the introduction of the steam.

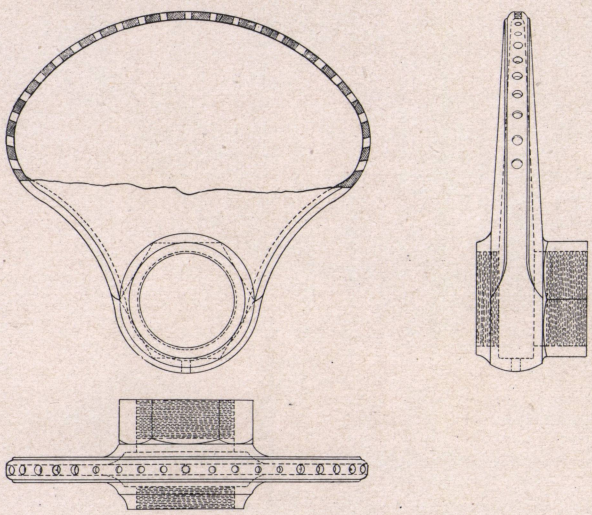
For best finished gas the steam supply must be evenly distributed to the



ELEVATION OF A 11'0" EXTENDED CARBURETTER SUPERHEATER WATER GAS APPARATUS.

Steam.

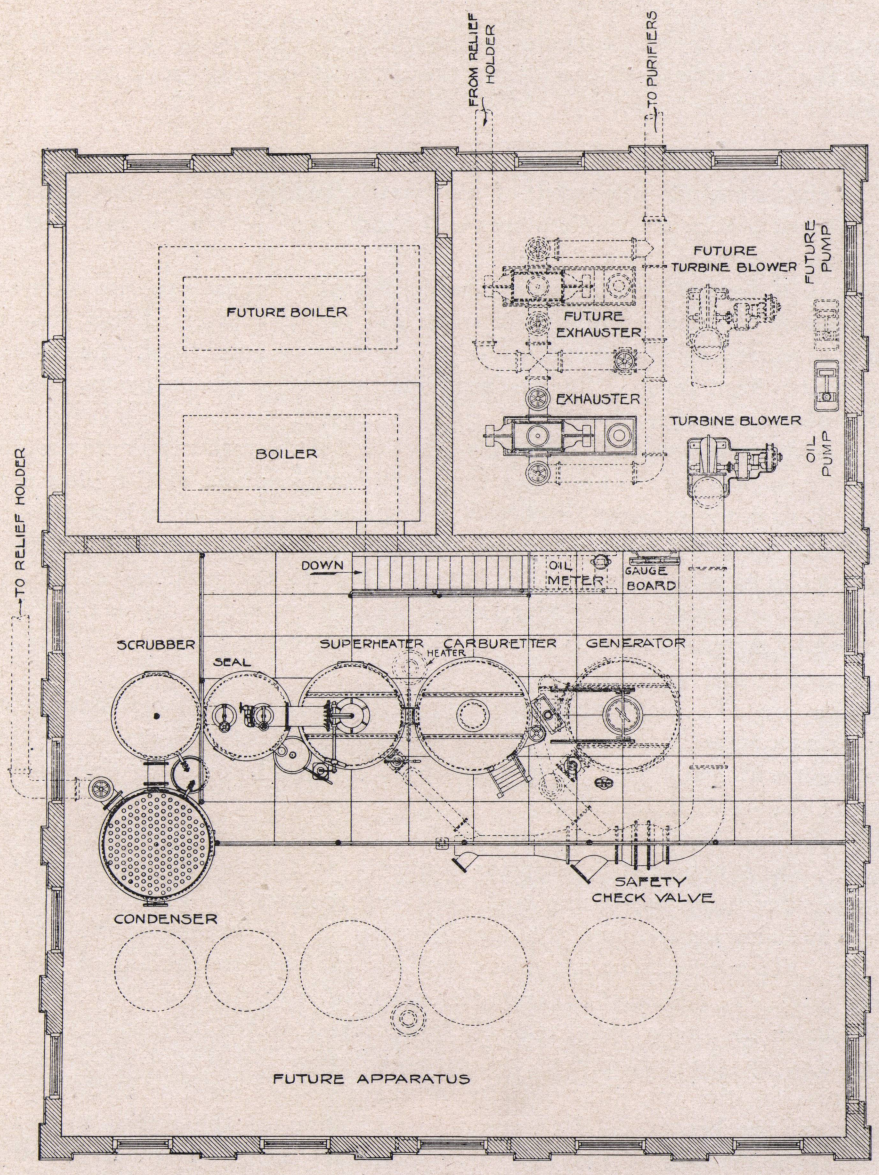
entire fuel bed. During the up runs, the steam is introduced below the grates in the ash pit, and unless it is directed upward toward the fire, there must necessarily be considerable condensation by direct impingement against the cool sides of the pit. Distributing the steam as close as practicable to, and directing its flow toward the fire, therefore minimizes condensation. And also by properly directing its flow the velocity of the steam is utilized, which very materially furthers the decomposition in the lower layers of the bed.



DETAIL OF STEAM DISTRIBUTOR. FOR POSITION UNDER GRATE SEE CUT ON PAGE 6.

It is essential that the steam on reaching the fuel be thoroughly dry. As its decomposition by contact with incandescent carbon is an endothermic reaction—the very reason that all water gas operation is intermittent—it is evident that the more entrained water there is in the steam, so much the more of the heat of the bed must be spent in converting this water to steam before the decomposition can proceed, and of course the part of the bed first met by this steam is the part most handicapped in its principal duty. When the steam, (especially if wet) is always admitted to the bottom of the fuel bed, the heats in this part are much more expended than on top by the heavy decomposition taking place therein. This is often to such extent that the lower parts of the bed become completely inactive, which condition is only aggravated when the blast is again turned on, further chilling of fuel and further wetness of steam results. For distributing the duty of the fuel bed throughout its entire volume, the flow of steam should be reversed periodically by making provision for admitting steam over the top of the fuel, and also providing a gas offtake connection from below the grates of the generator to the top of the carburetter.

To summarize upon the conditions for best quality and quantity of blue gas, it is essential:



PLAN OF A 7'6" HIGH CARBURETTER SUPERHEATER MACHINE SHOWING APPARATUS IN BLOWER AND BOILER ROOMS. FUTURE APPARATUS DOTTED.

Summary

First. That having provided a deep and uniformly heated fuel bed, the thoroughly dried steam is admitted and distributed evenly to the entire surface of the fuel bed, and as close as practicable to the fuel.

Second, That a simple means is provided for reversing the flow of steam through the bed periodically, so that the duty of the fuel may be distributed throughout its entire bulk.

Oil Enrichment

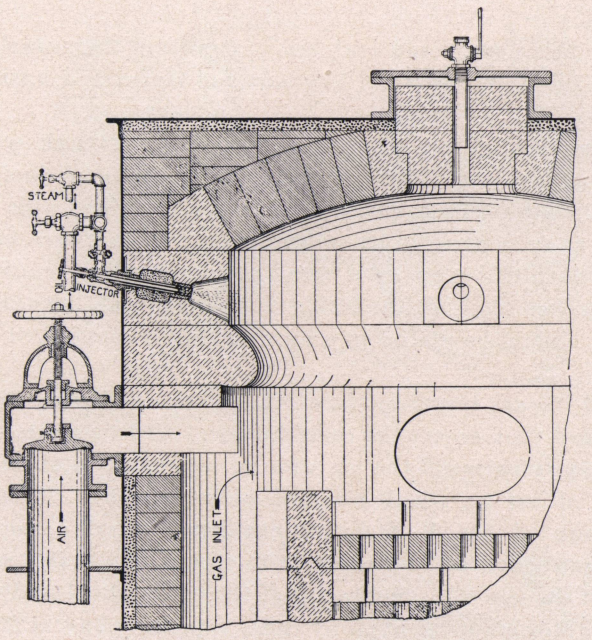
The aim in the oil enrichment of blue water gas is to use the least quantity of oil to carburet to a given candle power with least waste of the oil and with least destruction of checker brick.

The chief item to be guarded against in this phase of the problem is the excessive formation of either lampblack or water gas tar, a greater or less amount of which is produced in the operation of all water gas machines. Lampblack is formed by too high heats in the checker brick, and water gas tar by too low heats with insufficient checker brick area.

Now as the upper sections of the checker brick of the carburetter are the hottest, being the first ones with which the highly heated products of the blow come in contact, there is the greatest liability of the formation of lampblack at this point, especially so when the oils are sprayed vertically downward upon the bricks, as is the practice in most machines. The impetus given to the particles of oil by the high pressure in the oil supply pipe behind the point of spray, drives them against the heated brick before there is a possibility of their being thoroughly vaporized or incorporated in the incoming blue gas.

There are two ways of minimizing this formation of lampblack; first, by thorough admixture of the vaporized oil with the incoming blue gas, before coming into contact with the heated brick, and second, by low heats with extended time contact of vapors with the brick.

The oils on reaching the injector are first atomized, then vaporized and finally gasified. The function of the injector is merely to thoroughly atomize the oils, while the subsequent vaporizing and gasifying requires the agency of heat and time contact also for allowing the incorporation of the vapors in the protecting blue gas. For minimum of lampblack and also for least destruction of the upper checker brick, the oils *must be thoroughly atomized, vaporized and incorporated in the blue water gas before contact with the brick.* And as the impetus given to the oil particles by the pressure in the oil supply pipe is essential for the thorough atomization of the oil, this velocity of the particles must be dissipated before reaching the checker brick if thorough vaporization of the oils is to be accomplished, if the flashing of the vapors to lampblack is to be obviated, and if the vapors are to be incorporated thoroughly in the blue gas. The only logical means of obtaining these results is to spray the oils *laterally* into an entirely unobstructed chamber maintained at a comparatively moderate heat.



SECTION THROUGH EXTENDED CARBURETTER SHOWING ARRANGEMENT OF LATERAL SPRAYS.

The second condition for best results in oil enrichment requires that the checker brick in the carburetter be kept at a comparatively low heat. The entire quantity of vapors in the gas can then be taken care of by increasing the checker brick area, thus giving longer contact of the vapor laden blue gas with the checker brick. A second and equally important point is gained in that the oil, by longer contact at lower heat, is decomposed more into the heavier or illuminating hydrocarbons, rather than to those of low illuminating value.

Another point to be noted in connection with the question of oil enrichment is that of minimizing the destruction of checker brick, which can only be accomplished by arresting the cinders and ashes carried over to the carburetter during the blow. This material, together with the hard carbon from any lampblack, forms a very objectionable conglomerate on the surface of the brick, causing deterioration and necessitating frequent renewals of the upper layers of the brick.

To summarize upon the oil question, it is essential for best oil results: Summary

First. That the oils, thoroughly atomized and vaporized, are thoroughly incorporated in the blue water gas before coming in contact with the heated checker brick.

Second. That the heats are low in the checker brick, to prevent formation of lampblack.

Third. That there *is sufficient checker brick area to fix all the oil vapors at this lower heat.*

And for least destruction of checker brick to provide a means of minimizing the amount of cinders and ashes reaching them during the blow.

Waste Removal

The gas after being made and enriched passes from the superheater at a high temperature, and laden with more or less soot and tar, which waste must be completely eliminated.

The gas passes through the seal, where, bubbling through water, it receives its first cooling and washing. Where excessive amounts of lampblack or water gas tar are formed, as a result of careless operation, much of this waste separates out at this point, as evidenced by its collection in the overflow tank of the seal. The overflow serves in this way as a very efficient indicator of the conditions existing in the checker brick of the fixing chambers; and for this reason the seal with its overflow, should be placed in a location most convenient for observation by the operator.

After the seal the gas traverses the scrubber and condenser for further washing and cooling, and then enters the relief holder. In larger sized works we often install and strongly recommend the use of a tar separator after the condenser for complete removal of any tar which may still be in the gas. What has been said concerning the use of the P. & A. tar extractor in coal gas apparatus, applies equally in water gas practice. Its object is to eliminate all tarry vapors at a temperature such that the volatile constituents of the gas most valuable for illuminating and heating, shall still be unabsorbed by these vapors. And as these tarry vapors increase in absorbing capacity with decrease of temperature, the proper position for the water gas P. & A. is between the condenser and the relief holder.

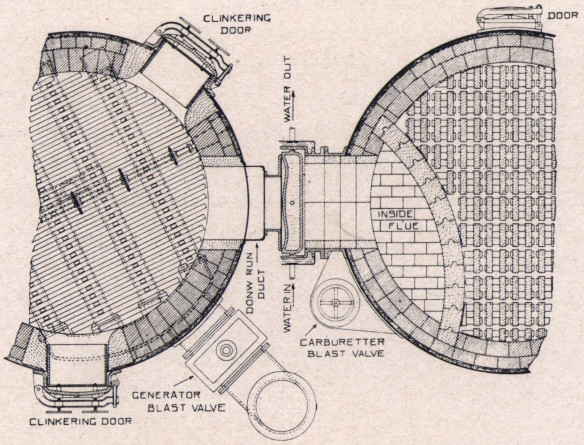
Construction

It will be noted from the points brought out in the above, that if correct conditions are to be attained, the construction of the machine in all its details is of greatest importance, and the machine which, intelligently operated, can produce and maintain the nearest approach to the ideal conditions, is the most worthy of the consideration of the discriminating gas engineer.

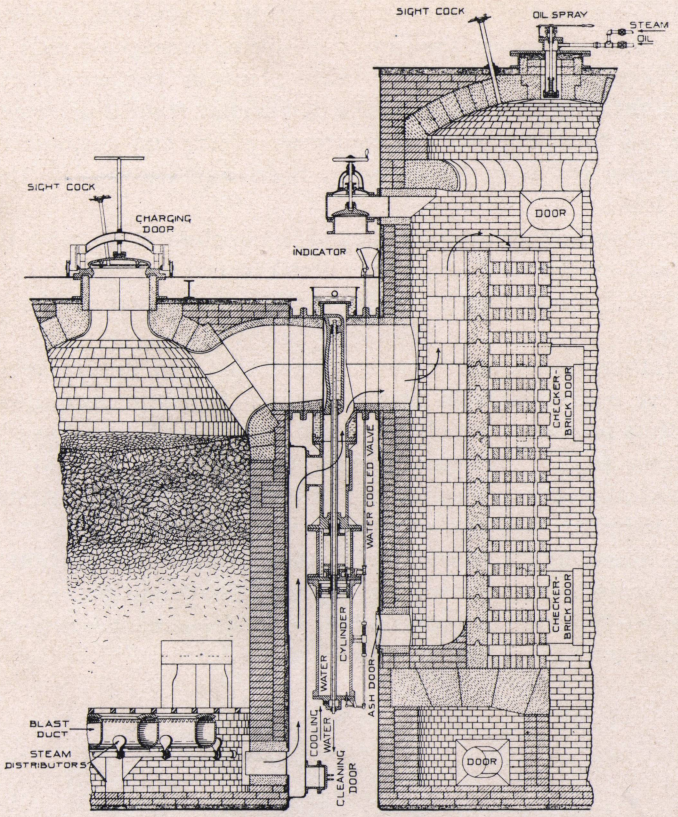
The "Western" Water Gas Apparatus is such, and the results that are obtained in numerous installations in all parts of the country serve to prove its superiority. As built at present, our water gas machines, particularly those of the Extended Carburetter Superheater type, embody several departures in the construction of this class of apparatus, which have repeatedly demonstrated their worth by increasing the capacity and efficiency of the apparatus.

With increased depth of fuel in the generator, and with the combination of divided blast bearing bars and steam distributors, best quality and quantity of blue gas is insured. This combination provides for higher blast pressure with uniform fire, least waste of fuel and minimum clinker, shorter blows and longer runs, which results in increased capacity and greater efficiency.

Our carburetters are built of same diameter as the generators, with internal uptake flue and vaporizing chamber, distinct from the checker brick chamber. The uptake flue placed in the side of the carburetter nearest the generator, arrests the



GENERATOR CARBURETTER



PLAN AND ELEVATION SHOWING DETAILS OF UP AND DOWN RUN MECHANISM.

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cinders and ashes carried over by the blast. Deposition of this material on the upper layers of the checker brick is thus prevented and fusion of the top courses of brick is minimized. The vaporizing chamber placed in the top of the carburetter is another strong feature of our apparatus. Into this chamber the oils are sprayed *laterally* and by its construction and location above the checker brick, a means is provided for diminishing the velocity of the atomized oils; also time is allowed for vaporization before leaving the chamber ; and complete incorporation of the vapors in the protecting blue gas is insured before contact with the checker brick.

We are prepared, however, to furnish carburetters having oil spray in the top if it is so desired. The arrangement is shown on the cut illustrating the details of our up an down run valve mechanism,

Our carburetters and superheaters are higher than those built by other concerns, which results in increased checker brick area. Maximum fixing capacity at comparatively low heat is provided and increased yield from the oil in candles per gallon is the direct result.

In connection with our extended carburetters, a feature of note is the convenient means provided for the proper regulation of the secondary air supply during the blow. As before noted, the content of producer gas from the generator is continually changing, and unless the supply of air is correspondingly changed, only an inefficient combustion and heating takes place in the carburetter. A glance through the sight cock in the side of the carburetter from time to time, will inform the operator as to the proper proportions of air and gas, and the careful and observing operator will soon learn that a little watchfulness in this respect will amply repay him.

Without going further into details and in conclusion, we wish to call attention to the finish and workmanship on every detail of our sets, which we spare no pains to make the best. Under this head also is the arrangement of the sets, in which detail we excel.

The operating mechanism is so arranged that the gas maker completes the entire cycle of operation from one position. Greatest convenience possible in operation is thus provided, which point will appeal to all who have had experience on the operating floor. This convenience of operation is brought about by means of our hydraulically actuated valves for generator blast, reversed steam and superheater stack, together with our automatic oil feed system.

With the above details provided and with the always important pressure board conveniently located, the operator may have all the conditions in all parts of the machine completely in his control, which, in a measure, accounts for the superior results obtained with our water gas apparatus.